Session 1 - Komponenten für den Netzbetrieb

26. CIRED – Internationale Konferenz für Stromverteilung

am 20-23. Sept. 2021 Online

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Details Session 1

- 136 (152 im Jahr 2018) Berichte in der Session 1 – Komponenten für den Netzbetrieb

- Berichte aus Österreich: kein österr. Beitrag in Session 1
  - 4 Blöcke
    - 24 Vorträge in der Main Session (je Block 6 Sessions)

  - 3 Round Tables (RT) – DC Netzwerke, Grüne Netzlösungen, Sekundär-Stationen der Zukunft
    - DC Netzwerke / Österr. Beitrag mit **Dr. Gerhard Jambrich**

  - 1 Research and innovation Forum (RIF)
    - 6 Vorträge im Research und Innovation Forum (RIF)

  - Alle Berichte wurde in der interactive Poster Session präsentiert

4 Blöcke Session 1

- **Session 1 – Komponenten für den Netzbetrieb**
  - Block 1: Anlagenmanagement und Zustandsbewertung von Netzkomponenten – Kabel, Freileitungen und assoziierte Komponenten (25 Beiträge)
  - Block 2: Anlagenmanagement und Zustandsbewertung bei Komponenten/Produkten für den Netzbetrieb – Netzstationen, Schaltanlagen und Transformatoren (39 Beiträge)
  - Block 3: Innovationen bei Netzkomponenten – Kabel, Freileitungen und neue Komponententypen (27 Beiträge)
  - Block 4: Innovationen bei Komponenten/Produkten für den Netzbetrieb – Netzstationen, Schaltanlagen und Transformatoren (45 Beiträge)

Organisation Session 1

Chairman:

- **Christophe BOISSEAU (France)**

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Rapporteure:

- **Arnaud ALLAIS (France)**

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1. Block Session 1

- Block 1: Anlagenmanagement und Zustandsbewertung von Netzkomponenten – Kabel, Freileitungen und assoziierte Komponenten (25 Beiträge)

- Hauptfokus:
  - Prüfen und Monitoring (5 Beiträge)
  - Künstliche Intelligenz und große Datenmengen (5 Beiträge)
  - Gesundheitsindex, Diagnostik und Ausfallserkennung (11 Beiträge)

- Paper 250 (FR, MS1.1): Impact of energy intermittence on cables and their accessories reliability

Experimental set-up

- 15 jointS from 2 different manufacturers
- 3 different installation modes for the cables (twisted, trefoil, in a duct)
- 210 thermal cycles (from 30 to 110 °C)

Experimental results : visual inspection

Thermal degradation on the joint components

Distortion of the cable core

Experimental results

N°	Joints	mode	Inspection results	Joint degradation level	Core distortion level
J1	Manuf A	Trefoil	Stopped after > 100 cycles	High	Medium
J2	Manuf A	Trefoil	Stopped after > 100 cycles	Very high	Very high
J3	Manuf A	Trefoil	Stopped after > 100 cycles	High	Medium
J4	Manuf B	Trefoil	Stopped after <10	Medium	High
J5	Manuf B	Trefoil	Stopped after > 50 cycles	Medium	Low
J6	Manuf B	Trefoil	Stopped after > 100 cycles	Medium	Low
J7	Manuf A	Trefoil	Stopped after > 100 cycles	High	Medium
J8	Manuf A	Trefoil	Stopped after > 100 cycles	High	Medium
J9	Manuf A	Trefoil	Stopped after > 100 cycles	High	High
J10	Manuf A	In a duct	Cycles finished successfully	Very low	Very low
J11	Manuf A	In a duct	cycles finished successfully	Very low	Very low
J12	Manuf A	In a duct	Cycles finished successfully	Very low	Very low
J13	Manuf A	Twisted	Stopped after > 100 cycles	Low	Very low
J14	Manuf A	Twisted	Stopped after > 50 cycles	Low	Very low
J15	Manuf A	Twisted	Stopped after > 100 cycles	Medium	low

2. Block Session 1

- Block 2: Anlagenmanagement und Zustandsbewertung bei Komponenten/Produkten für den Netzbetrieb – Netzstationen, Schaltanlagen und Transformatoren (39 Beiträge)
- Hauptfokus:
  - Sensor Integration und „upgrade to smart“
  - Daten für Asset Management
  - Dynamic rating, Adaptation to Distr. Energy Ressource (DER) Integration
  - Anwenderberichte für Diagnose, Wartung und Retrofit

- Paper 675 – Automatic Analysis Of Thermograms – Challenge In Thermal Monitoring Of Switchgears Using Infrared Cameras
- Paper 146 – Accelerated Ageing Test Facility For Mv/Lv Distr. Transformers: Results And Discussion

GITZEL, GEBHARDT, KOZEL

AUTOMATIC ANALYSIS OF THERMOGRAMS – CHALLENGE IN THERMAL MONITORING OF SWITCHGEARS USING INFRARED CAMERAS

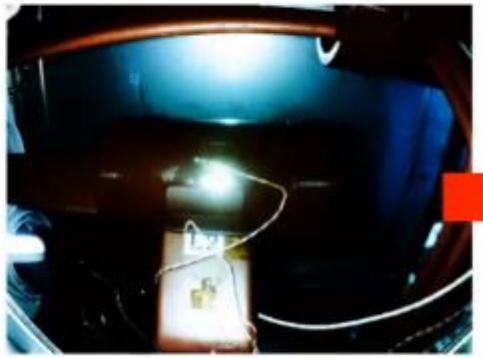
MV switchgear faces new challenges

Renewable energy provides fluctuating input to grid

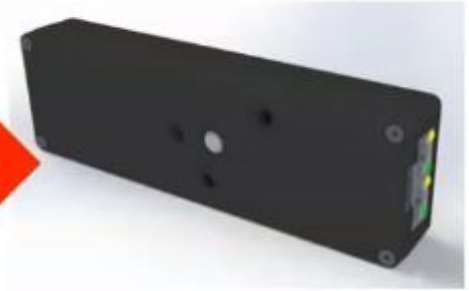
eMoblity produces new demand peaks

Higher stress on distribution network incl. MV switchgear

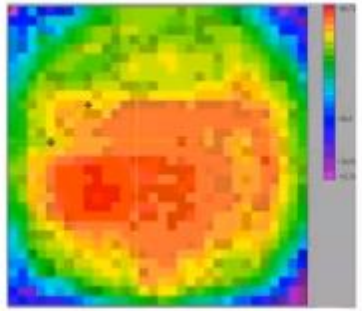
Infrared monitoring can detect thermal stressing



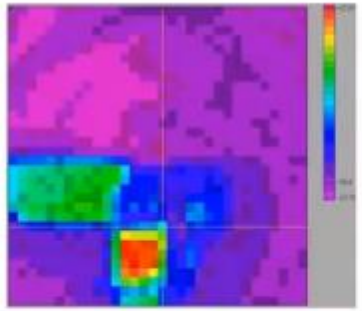
Interior of switchgear (e.g. busbar compartment)



Permantently installed IRT camera in compartment (e.g. ABB Multicom)



More or less equal heat-up means healthy state.



Hot spot indicates faulty state.

Automated analysis with the PixelCount algorithm

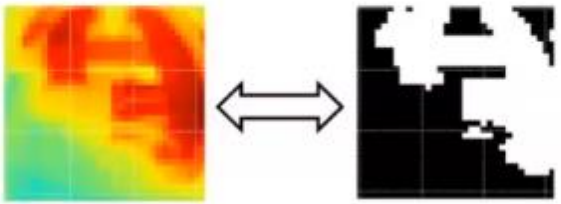
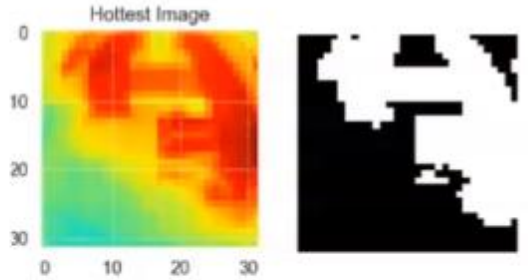
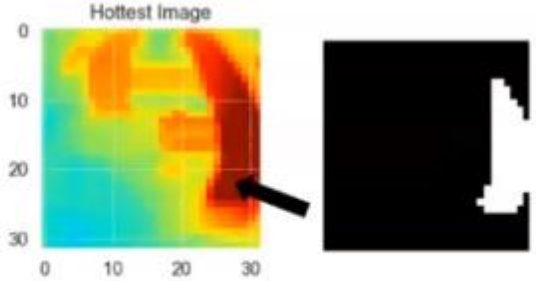


Image „Phases“

Apply a threshold to only show the hottest pixels (e.g. within 10K of the max temperature in the image).



Healthy cases have many pixels in the hot region (relative to max temp in image) because phases have more or less the same temperature



Faulty cases have fewer pixels in the hot region (relative to max temp in image, which is typically a lot higher) as the hot spot becomes a lot hotter than the other phases.

Conclusions and summary

Low resolution cameras can permanently monitor switchgear compartments

An automated solution is needed to continuously monitor large fleets of switchgear

By counting the number of hottest pixels, it is possible to detect hot spots without identifying phases beforehand.

The PixelCount algorithm shows good results on both healthy data and artificially introduced faults.

ACCELERATED AGEING TEST FACILITY FOR MV/LV DISTRIBUTION TRANSFORMERS *"RESULTS AND DISCUSSION"*

Jean Michel Couyade[1], Yves Bertrand[1], Mehdi Kanoun[1], Jean Pierre Gontier[2]

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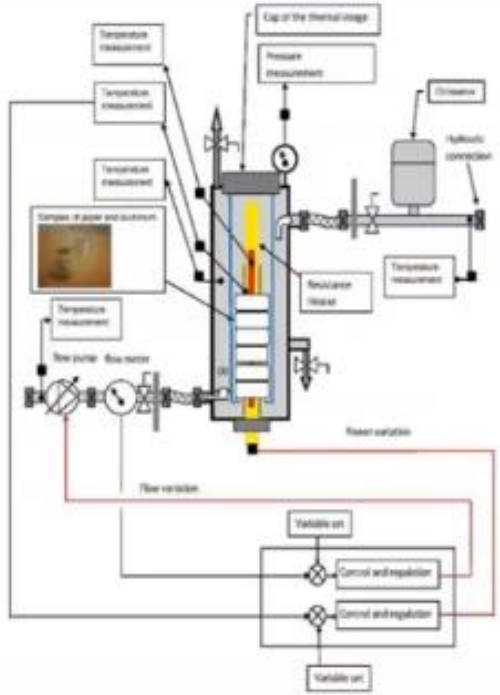
Context and motivation

- ❑ More than 792000 MV/LV transformers
- ❑ The transformer is a key element in the distribution network
- ➔ Anticipate its failure and its end of life
- ➔ Deep understanding of its degradation mechanisms
- ➔ Validate the ageing law through experimentation

Accelerated ageing test facility for MV/LV distribution transformers

Set-up of an Accelerated ageing test facility for MV/LV distribution transformers

- **Able to test two transformers with a calibrated charge**
- **Instrumented to measure the ageing parameters : Image Box**



Thermal Image Box schematic

Experimental results: Lifetime assessment

Ageing model

- In 2018, an ageing model of the isolation paper was proposed in IEC 60076-7 taking into account the humidity factor
- This law takes into account the chemical environment of the paper, such as humidity and acidity (A Factor) as well as the oxidation and the hydrolyse (E_A)
- This model is based on ageing of paper/oil on a laboratory bench

$$t(année) = \frac{\left(\frac{1}{DP(fin)} - \frac{1}{DP(début)}\right)}{A \times 24 \times 365} \times e^{\left(\frac{E_A}{R \times (\theta_H + 273)}\right)}$$

Results on Kraft paper

- According to the Accelerating ageing facility, the lifetime is about 1,8 year (DP reached 200)
- The computed lifetime form the model published in the IEC 60076-7 norm is 1,9 year

Results on TUP paper

- According to the Accelerating ageing facility, the lifetime is about 2 year (DP reached 200 and high humidity rate in the paper)
- The computed lifetime form the model published in the IEC 60076-7 norm is 2,1 year

There is a good agreement between the calculated and measured values

Conclusions & perspectives

Conclusion

- An innovative ageing test facility, dedicated to distribution transformers
- Correlation between the degree of polymerisation of the TUP paper and the concentration of EtOH in oil
- The relevance of using ethanol as tracers to monitor the transformer
- Experimental results are consistent with the aging model proposed by the latest edition of IEC 60076-7
- The TUP kinetic of degradation is slower than that of Kraft paper

Perspectives

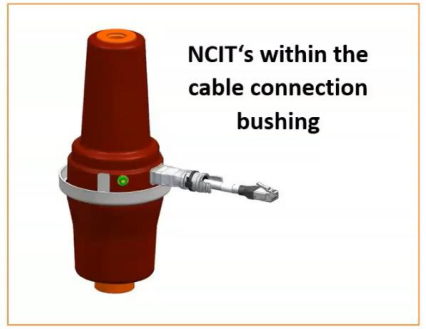
- Additional tests on extracted transformer from the field to confirm those observations
- Further studies on other transformers with other insulating systems

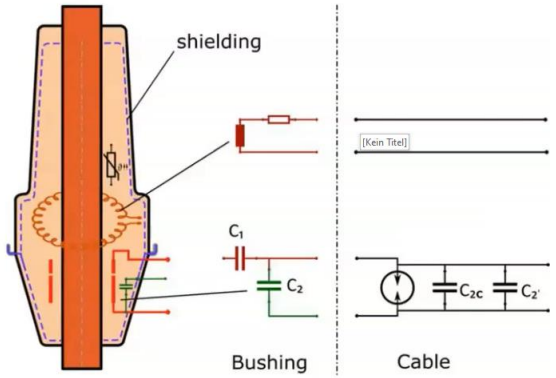
3. Block Session 1

- Block 3: Innovationen bei Netzkomponenten – Kabel, Freileitungen und neue Komponententypen (27 Beiträge)

- Hauptfokus:
  - Materialien und Modelle (7 Beiträge)
  - Zähler und Monitoringsysteme (6 Beiträge)
  - Systeme für Personenschutz und Betriebssicherheit (7 Beiträge)
  - Komponenten für die Schutztechnik und Netzstabilisierung (7 Beiträge)

- Paper 0744 (DE, MS1.3): Cable connection bushing type C according to EN 50181 with Rogowski coil current sensor and capacitive voltage sensor according to IEC 61869-10 and IEC 61869-11





- „Smarter" MSP-Kabelendverschluss für gasisolierte Schaltanlagen,
- Endverschluss Typ C mit
- integriertem Rogowski-Stromsensor und
- kapazitivem Spannungssensor,
- inkl. IEC-Qualifizierungstests.

- Paper 1007 (FR, MS1.3): Accurate thermal monitoring by sensor embedded in switchgear bushing

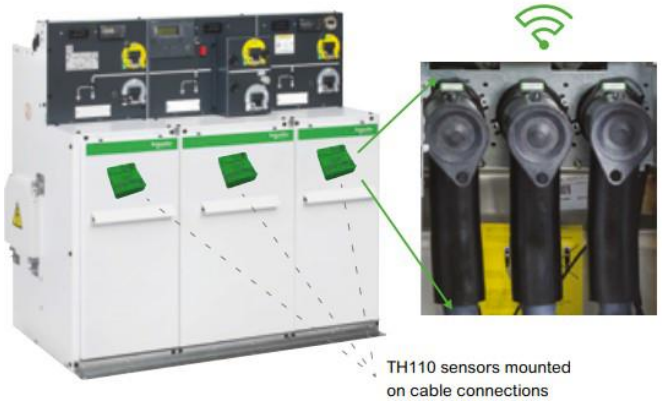


Abb.: Beispiel einer RMU. Detail GIS-Kabelendverschlüsse und externe Temperatursensoren

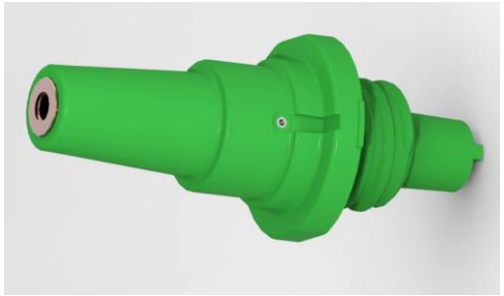


Abb.: Beispiel eines Temperatursensors eingebettet in einen „smarten“ MSP-Kabelendverschluss

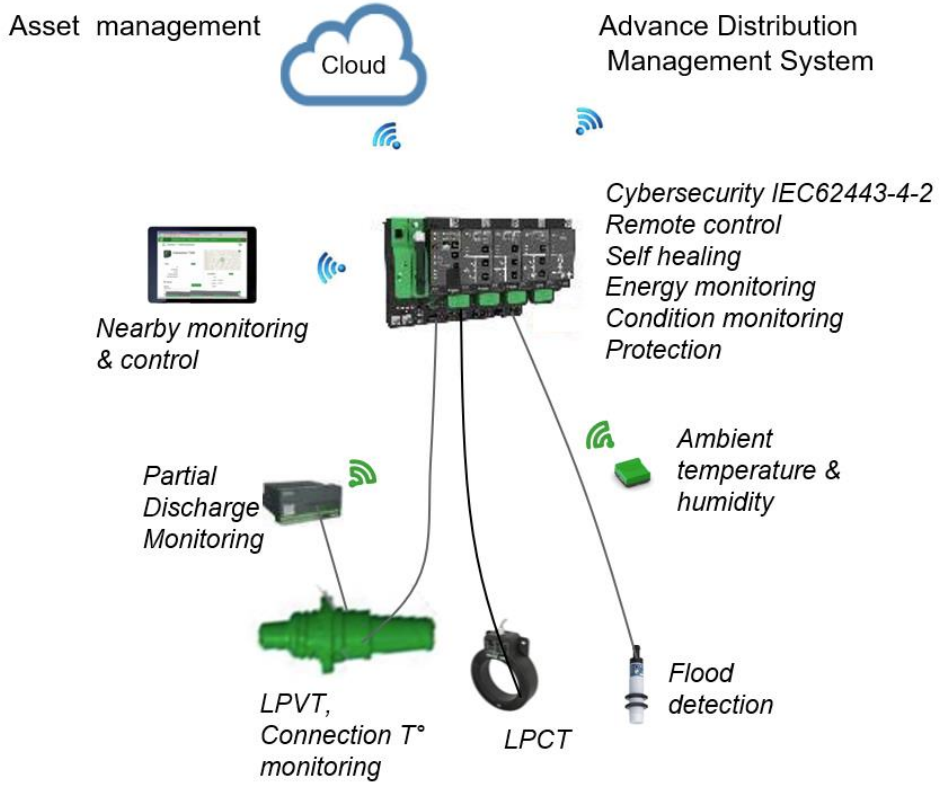


Abb.: Beispiel einer digitalen Architektur mit „smartem“ MSP-Kabelendverschluss für das Temperaturmonitoring

4. Block Session 1

- Block 4: Innovationen bei Komponenten/Produkten für den Netzbetrieb – Netzstationen, Schaltanlagen und Transformatoren (45 Beiträge)

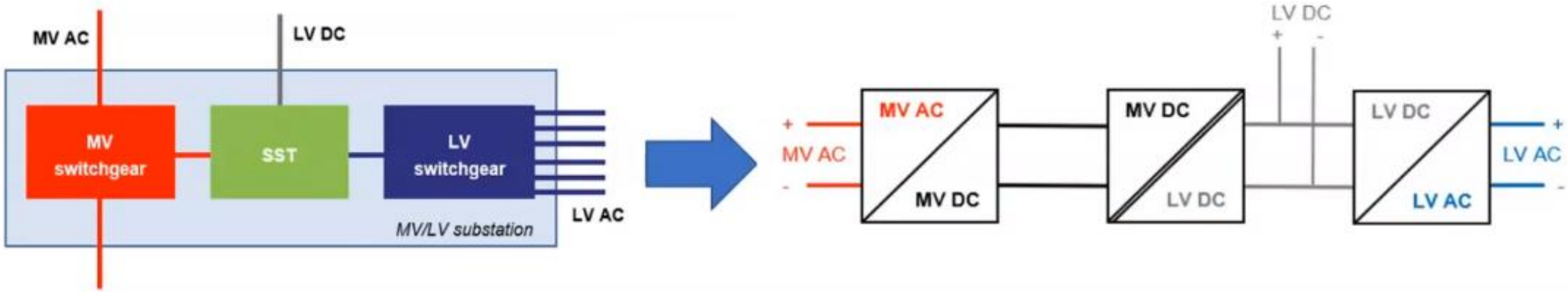
- Hauptfokus:
  - Grüne Komponenten
  - Smarte Trafostationen
  - Innovative Netzwerk Komponenten
  - Methoden und Tools für Komponenten Design

- Paper 365 – Feasibillity of implementing MV/LV Solid State Transformer in Dutch Electricity Grid
- Paper 435 – Assessing real alternatives to MV SF6 gas isnsulated switchgear
- Paper 890 – A carbon free mobile supply solution for planned outages

Feasibility of Implementing MV/LV Solid State Transformers in the Dutch Electricity Grids

- From Economic Perspective

Defining SST



- SST consists of a system controller with a filter, and the measuring and protection units.
- Main conversion block has stacked modules of AC/DC converters and DC/DC converter modules. This part converts 10 kV AC voltage into 700 V DC.
- Last part contains an inverter unit for DC to AC conversion and a filter to eliminate noise signal.

Features of SST

- Voltage control can be done efficiently.
- Capacity can be increased easily.
- SST provides a DC connection.
- It can compensate harmonics in the network.
- Gives voltage support during voltage dips in the network.

Current State of Art

Criteria	CTT (with tap changer)	SST
Power quality performance	Limited ability to control dynamic voltage variations	Claimed to perform efficiently under varying load conditions
Size	Compact product, readily available.	Modular construction. Size is larger than CTT.
Maintenance needs	Virtually maintenace free	Needs some amount of maintenance because of power electronics components.
Initial Investment	Known product. Much lower than an equivalent SST.	New product. Present cost is high, predicted to go down sharply in future!

Conclusions

- Present investment cost of SST quite high. It will be more effective in the grid if the high pace of energy transition continues.
- Main advantages of a SST are its voltage quality improvement feature and the availability of DC connection point.
- New development of power electronics technology and its decreasing price has a direct impact on the cost of SST.
- SST has a promising future if the high initial investment is decreased.

Assessing real alternatives to MV SF6 gas-insulated switchgear

Introduction

Ormazabal has investigated different gases for insulation and/or making & breaking purposes:

- **Natural origin gases:** N2, CO2 & Dry Air
- **Fluorinated gases:** C5-FK, C4-FN, HFOs alone or in gas mixtures of 2-3 components including natural origin gases

Technically, several possibilities were found viable but not all with same attributes and/or limitations.

Then, the question is…

Attributes

Dimensions of equipment

Alternative **gas** selected

Reliable and safe **overpressure**

Transformer protection:

Fuse vs CB

To maintain same **operation and exploitation procedures**

Conclusions

- The final validation of different alternatives is not an easy task and will take a long way (there´s not a like for like solution to SF6), as there is still:
  - not clear regulatory framework,
  - not enough field experience,
  - not accepted standards to validate those alternatives, and
  - many different applications and specifications.

- All alternatives have implications. Importance on analysing consequences and impacts in each attribute to take the best decision for the future.
- Proposed alternatives must first ensure the users about the maturity and reliability of the technology, so they should be assessed through well monitored pilots at selected locations, involving both manufacturers and DSOs.

Conclusions

- However, for medium-voltage secondary distribution application, a new possibility based on:
  - **Natural origin gases** (N2, O2 & CO2)
  - at **very low overpressures (< 50 kPa)**
  - in a **sealed** stainless steel **tank (GIS)**, with protection from atmospheric conditions.

Better alternative to respond to environment, users and manufacturers.

- In addition, it is worth to analyse **in future installations** the implications of:
  - Slightly increasing (if necessary) the dimensions
  - Evolution of installations and transformer substations (Tier-2-3 transformers, smart grid deployment…)
  - Removing other uncertainties whose impact is less measurable

Conclusions

- In all cases, the proposed alternatives shall at least cover the same
  - Safety
  - Performance
  - Reliability
  - Required maintenance

  as present solutions based on SF6 have.

- Otherwise, the use of SF6 should be kept for:
  - Specific applications
  - Certain levels of voltage networks
  - For **retrofitting purposes** in some critical installations (such as compact substation and/or large installations)

A carbon free mobile supply solution for planned outages

Presenters :

- Julien Lefaucheur (Enedis, France)
- Geoffrey Auran (EDF, France)

A carbon free mobile supply solution for planned outages

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- Julien Lefaucheur (Enedis, France)
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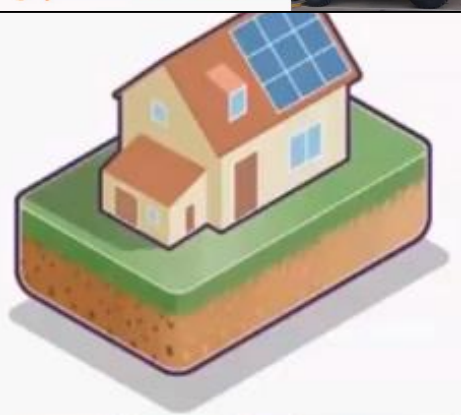
Why is an innovation needed ?

- 20000 uses of Diesel Generators each year
- Disconnection of electric producers during planned outages
- Reduction of greenhouse gas emissions

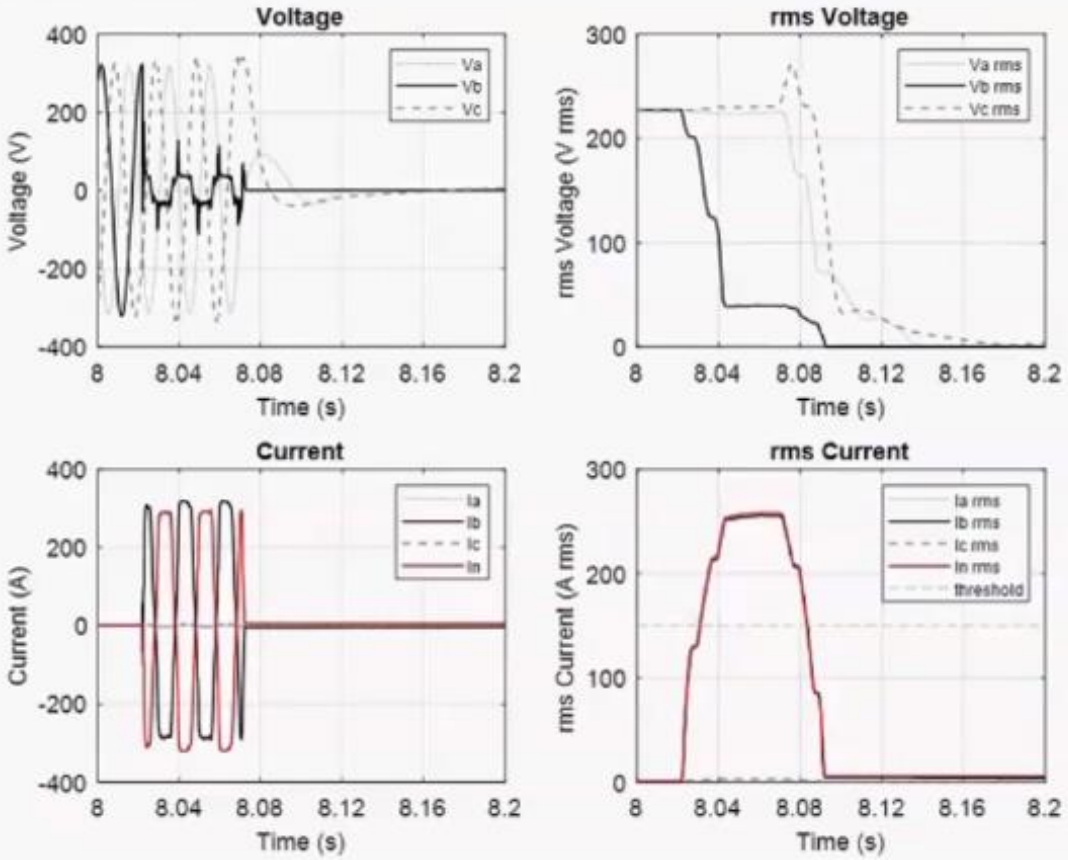


Our carbon free mobile supply solution

- 200kWh energy capacity
- 62kW power
- 20 battery storage units
- 5t weight

Laboratory tests for validation

- Batteries charge and discharge tests
- Short-circuit and Earth faults
- Disconnection of producers with frequency modulation
- Done at Concept Grid laboratory facility (EDF R&D Lab Les Renardières)



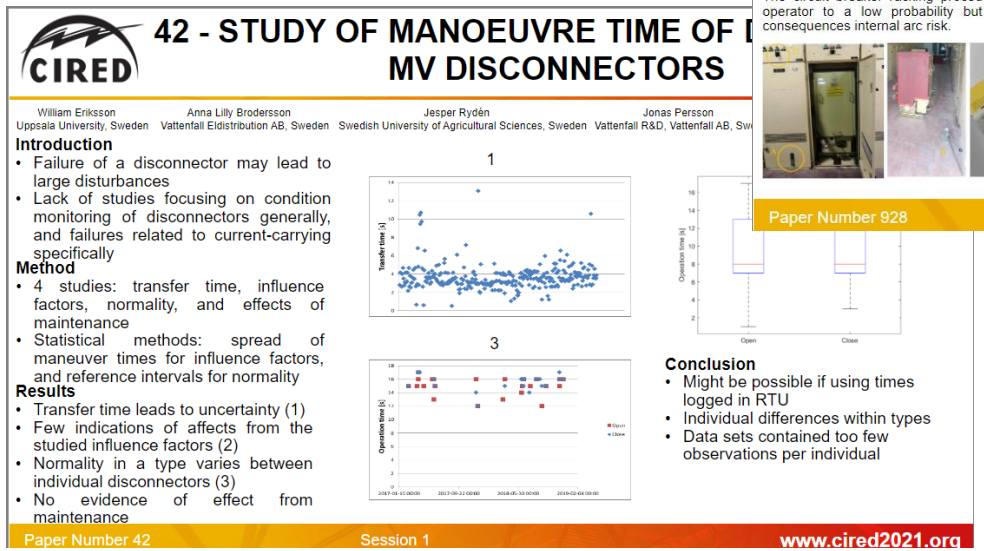
Results of a phase-to-neutral short-circuit fault

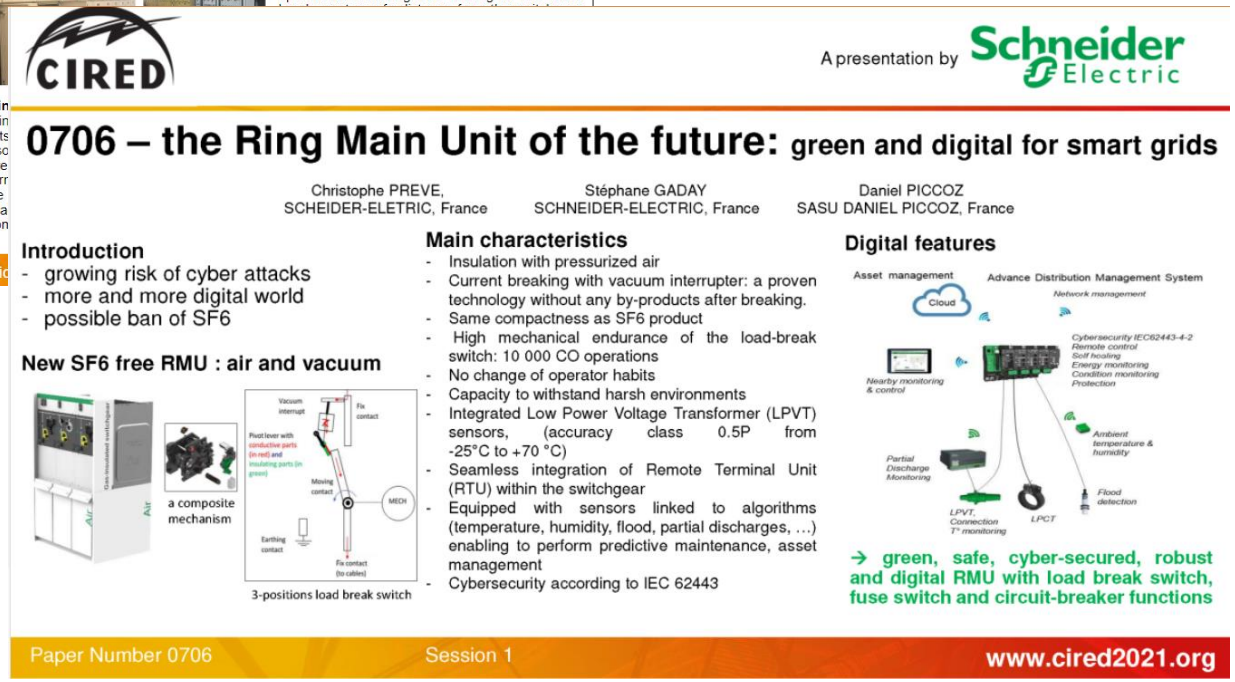
Conclusion

- Can be used instead of Diesel generators
- Can use and store the renewable production
- No greenhouse gas emissions and less disturbances for neighborhood
- The feedback will serve for next similar projects

Postersession

- Postersession:
  - 103 Poster der Session 1





Besten Dank für die Aufmerksamkeit!

Kontakt: www.cired.at / cired@ove.at